Defense Sciences Office

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Defense Sciences Office

Who we are:

- A collaborative team of diverse, opportunistic technology entrepreneurs
- "DARPA's DARPA" – office that creates DoD opportunity from fundamental scientific discovery
- Informed, but not constrained, by current trends and conflicts

What we do:

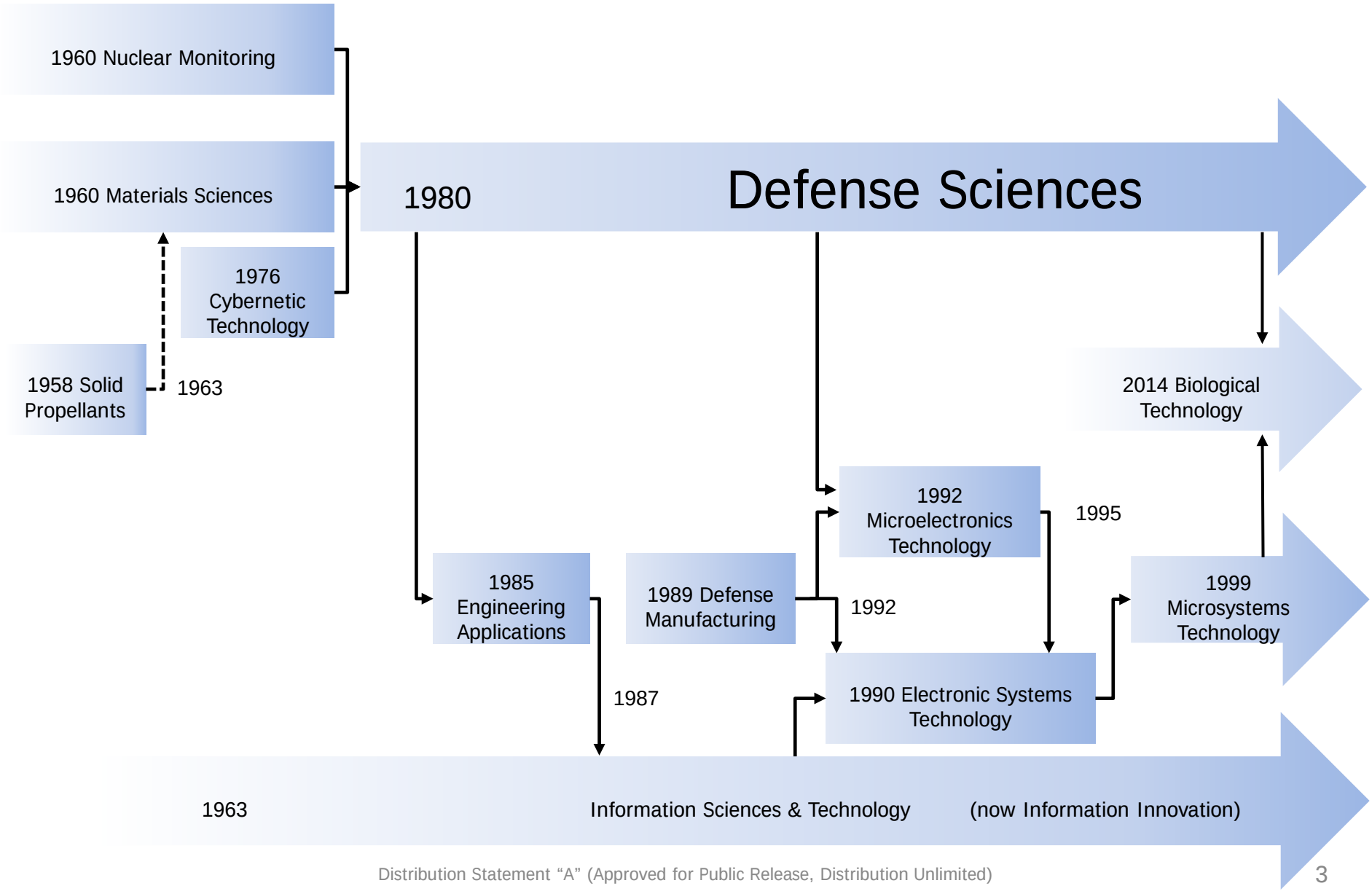
- Invest in multiple, often disparate, scientific disciplines
- Reshape existing fields or create entirely new disciplines (sometimes when the payoff to DoD may not be fully understood)
- Harvest and accelerate the development of promising breakthroughs to create enabling technologies for broad impact against national security challenges

What we don't do:

- Large systems, where the risk is primarily engineering or integration
- Incremental research – DSO primarily focuses on pivotal, early stage investment in high risk opportunities

The Nation's first line of defense against scientific surprise

DSO Office History



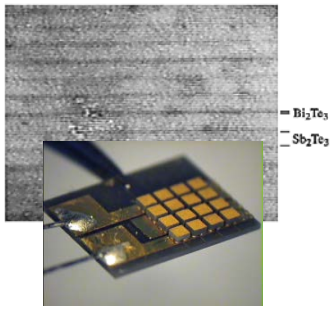
DSO Contributions to Materials Science

IDL Building at U. Penn, one of the first four IDLs

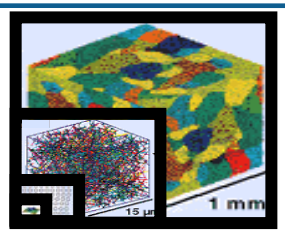
Infrared Astronomy Satellite

Titan payload adapter with Al-Li alloys

High performance gyroscopes



Superlattice Thermoelectrics



Engineering Design Processing

Interdisciplinary Research Labs

Beryllium Mirrors

Ceramic Materials Design

Lightweight Al-Li Alloys

Precision Ceramic Bearings

Thermoelectrics

Accelerated Insertion of Materials

1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010

Explosive Forming

Glassy Carbon

PtSi IR Focal Plane Arrays

"Splat" Cooling

Ceramic Composite Armor

Spintronics

Heterostructural Uncooled Magnetic Sensors

Low Temperature Colossal Supersaturation

Titanium chine plates using explosive forming techniques

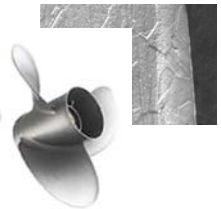
Glassy carbon heart valve

IR cameras with PtSi sensors

Neodymium magnets formed by rapid quenching

Lightweight armor for aircraft and rapid-deployment vehicles

Spin based electronics - Spintronics



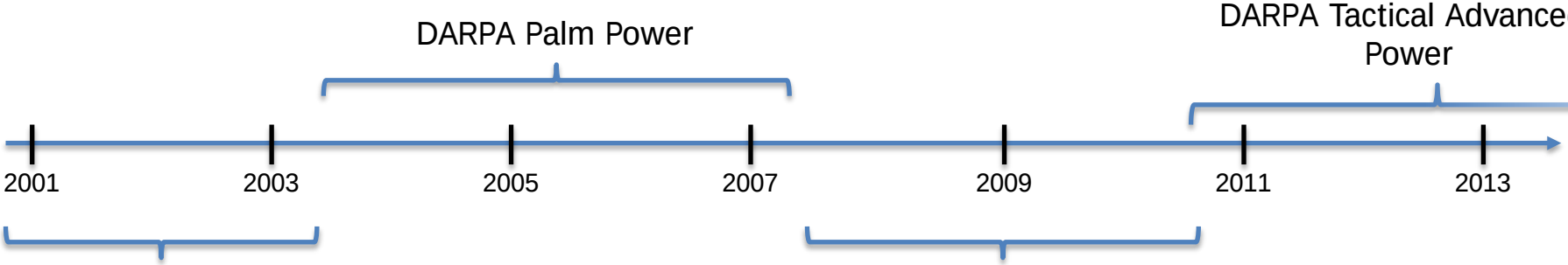
Corrosion/Erosion resistant surfaces

Solid Oxide Fuel Cells (SOFC) Timeline

Thermally self sustaining breadboard

First ever portable SOFC system

SOFC Stalker XE240



Microtubule SOFCs

SOFC powered UAV and UGV demonstrations

Cold Atom Sensor Development

Cold atom gyroscope at Stanford (M. Kasevich)

Laser cooling & trapping at Bell Labs (S. Chu)

Optical ion clock demonstrated at NIST (D. Wineland)

Low Dynamic Range

PINS Phase II
Single-axis gyro-accelerometer

QuASAR Phase I
Optical atomic clock

1985 1995 1997 1998 2001 2004 2006 2009 2012

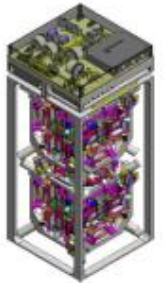
BEC at UC-NIST (E. Cornell & C. Wieman)

PINS Phase I
Initial demonstrations. Cold atoms and Bose Einstein Condensates (BECs) explored.

gBECi:
BEC projects split off.

NIST-F1 cold fountain clock comes online (S. Jefferts)

High Dynamic Range



PINS-HiDRA
Phase I

National Security Challenges

- Diverse threats: Expanding military missions in widely varying environments demand a level of customization that we do not have
- Speed of change: Globally available technology is moving more quickly than we typically react
- Complex systems: Unsustainable cost of military systems limits adaptability, choice, and incorporation of new technology
- Erosion of boundaries: Weapons of terror and potential proliferation of WMD technology affect both war and peace, home and abroad

Key questions we in DSO are considering

- Diversity: Can we rapidly accelerate scientific discovery and innovation?
- Speed: Can we remove technology barriers to rapid or low volume acquisition? Can we create new capabilities quickly, to respond or adapt to unpredictable threats?
- Complexity: Can we harness complexity in the systems we build? Can we quantify and manage uncertainty and risk for robust, less costly systems?
- Erosion of boundaries: Can we enable reliable and timely detection and management of CBRNE threats?

Bubbling Technology Opportunities

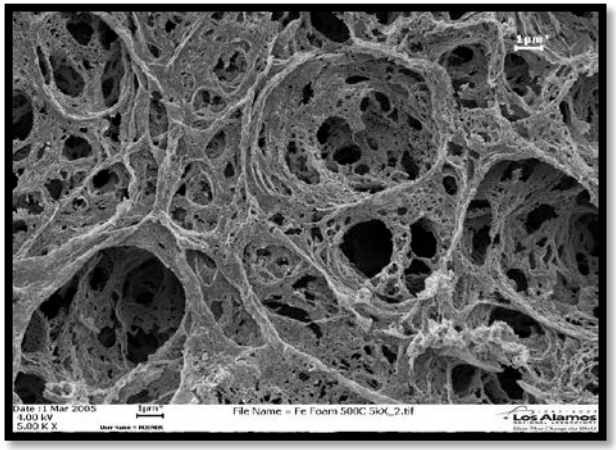
???

(Tell us what you think they are)

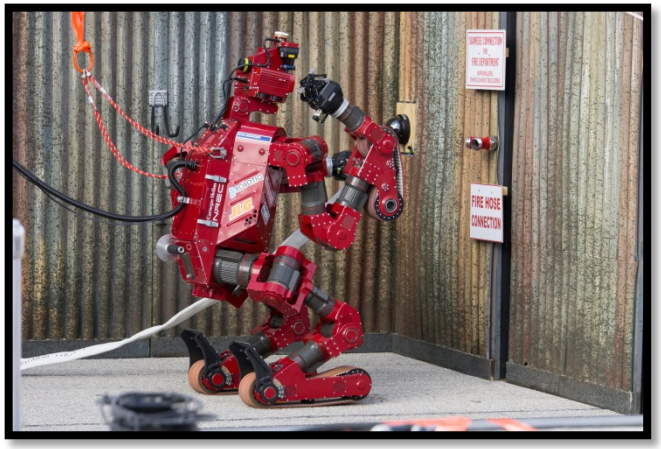
Types of Programs

Foundations	Tools	Integrated Demonstrations
• Monitor and explore scientific frontiers across multiple disciplines to create new communities and capabilities • Mostly measurement and theory	• Exploit discoveries to develop tools • Translate capability from within a research community to outsiders • Increased focus on use cases and potential CONOPS	• Bring together multiple lines of research into a new capability, outside the laboratory • Often opportunistic, and/or driven by specific DoD needs

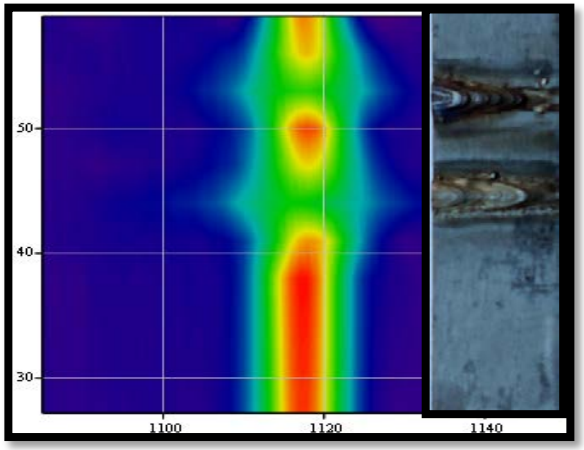
Topic Areas



Transformative Materials
Decoupling and control of countervailing material properties; design and fabrication of new materials across multiple length scales



Supervised Autonomy
Development of theory, tools, and components to enable extended autonomous activity in unstructured, infrastructure-poor environments



Novel Sensing and Detection
New approaches to sensing and detecting CBRNE materials and devices

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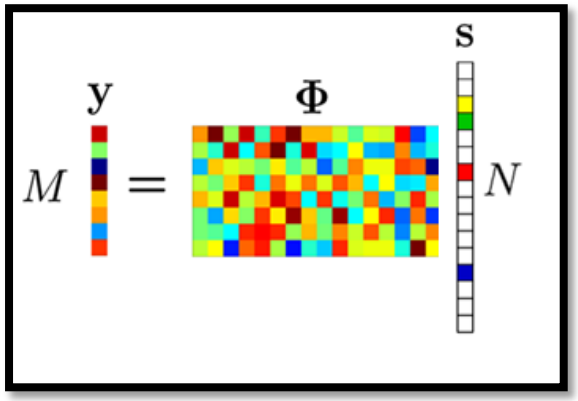
Physical Sciences
Exploration of scientific breakthroughs and boundaries that enable unique capabilities for national security



Mathematics
Development of advanced mathematics and modeling tools

© 2007 Ned Batchelder

Complexity
Exploration of the science of complexity, and its application to new engineering paradigms

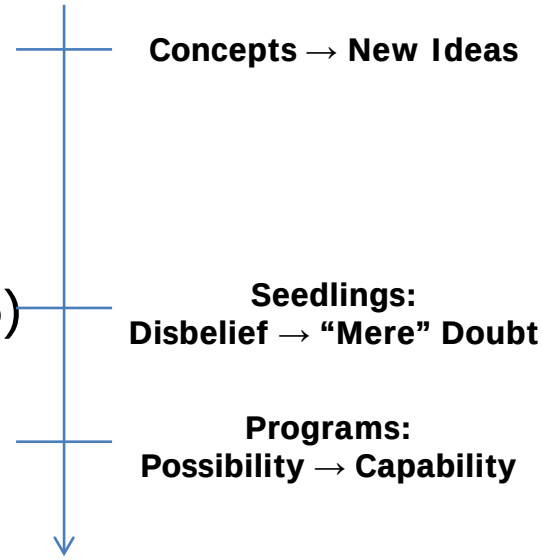
Three ways to engage with DSO

Talk to a Program Manager (PM)

- PM sidebars tomorrow
- Email/phone/face to face throughout the year

Submit ideas to the DSO Office-Wide BAA (BAA-14-46)

Respond to DSO program BAAs



Heilmeier Catechism

- What are we trying to do?
- How does this get done, at present?
- What is new about our approach?
- If we succeed, what difference do we think it will make?
- How long do we think it will take?
- Can we transition?
- How much will it cost?

Program Managers

Fariba Fahroo
Mathematics

Mark Micire
Robotics

James Gimlett
Physics

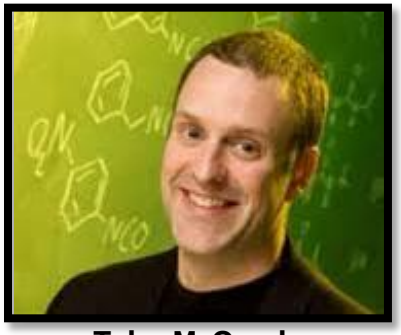
Judah Goldwasser
Structural Materials

Doran Michels
Ground Combat Systems

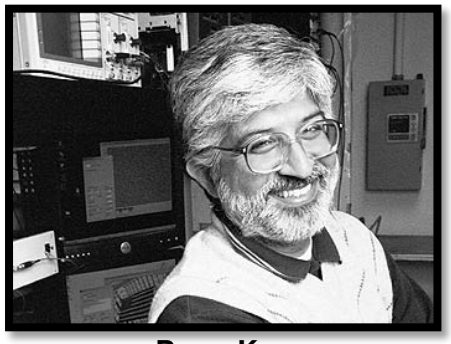
Michael Maher
Materials and Manufacturing

Gill Pratt
Robotics and Neuromorphic Systems

John Main
Material System Innovation



Tyler McQuade
Chemistry



Prem Kumar
Quantum and Nonlinear Optics

Reza Ghanadan
Complexity Science

Vincent Tang
Applied Physics

DEFENSE SCIENCES OFFICE

We look forward to your ideas.